# NASA Activities

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**November 1976**

## Cover

**Straight Up, Straight Down**—Under testing for the Navy at NASA's Ames Research Center is the AV-8B Advanced Harrier, an improved version of the Harrier fighter aircraft. The Harrier, which can land and take off vertically, is presently in service with the U.S. Marine Corps. The Advanced Harrier will incorporate new aeronautical technology, including a wing made of composite materials and a NASA-developed supercritical airfoil for increased flight efficiency. Tests take place on the Ames static test stand and in the 12- by 24-meter (40- by 80-foot) wind tunnel, the largest in the free world. Contractor to the Navy for the test is the McDonnell Douglas Corp.

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# Letter from Washington

Dear Colleagues:

With the advent of Sputnik and the ensuing national resolve that America wanted a national space program, it became evident that a new civilian agency was needed to lead the effort. Thus the venerable NACA was absorbed into and became the nucleus of the new National Aeronautics and Space Administration. Although the agency's accomplishments in space have since captured the public's attention, aeronautics remains one of our principal responsibilities. Today, on paper at least, it would seem that the United States is riding high in the field of aviation. Seventy-eight percent of the free world's transport planes are built in the United States—and even mainland China has joined our list of customers; sales feed into an American aerospace industry employing 965,000 skilled workers with an annual payroll well above $13 billion. The technology base capability created in our industry, in large part due to NASA's effort, is a national asset in its own right. It is no secret that our nation dominates the world aircraft market and that the agency provides the technology base for both military and civil aircraft. Simply stated, we have built planes of superior performance.

But there is no guarantee that U.S. leadership is inviolate. Even apart from the SST, every rollout of a new commercial aircraft model in a foreign country means that competition is stiffening. Since air carriers in this country presently are not in a position to stimulate new aircraft development, and because the world's foreign markets are growing faster than ours, American manufacturers must work harder than ever to have their aircraft accepted by non-U.S. airlines. It may well be that the Congressional decision not to build a supersonic transport gave impetus to completion of the European version. Although NASA is not advocating that we build our own SST, it should be clear to us that our resolve remains firm to maintain and support U.S. industry leadership in civil aviation. NASA's mission is to develop the technology necessary to insure that our aircraft remain more than competitive with the rest of the world.

In the near term, we are addressing the technology development related to fuel conservation, safety, and emission and noise reduction. In the long range, NASA engineers are pointing toward a new generation of aircraft—aircraft with first-rate capability and productivity at a lower technical and financial risk.

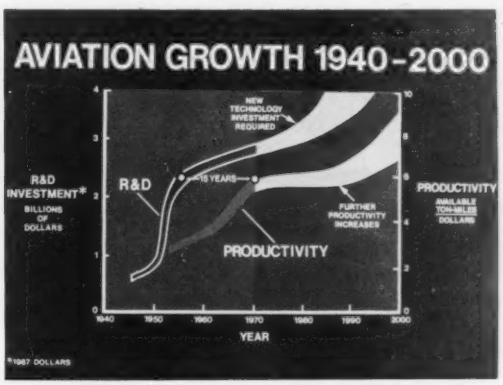
At NASA, our sights are raised and our objectives are clear. Our aeronautical research and technology development are paramount to this country's transportation system, economy, military preparedness, and to its sustained world leadership.

No airline willingly either buys or operates an aircraft that is not efficient, particularly if there are better options available on the foreign market. The aircraft that we develop and build for sale to other countries, if they are reliable, adaptable, and have ready replacement components, can provide a positive thrust to our economy and aid in keeping a favorable balance of trade. While today's aircraft sales are based on current technology, tomorrow's competing edge will be based on today's research and technology. NASA must continue its leadership in providing the tools necessary for maintenance of that competing edge.

Sincerely,

A. M. Lovelace

A. M. Lovelace




**Aeronautical Progress**—The general pattern of civil aviation growth in the U.S. is depicted in this chart, in terms of research and development investment, and aircraft productivity. Between 1940 and 1955, national support of research and technology brought about the introduction of the jet engine, the swept wing and the wide body structure. Major improvements in productivity followed as a consequence in the subsequent 15 years. Continued growth thereafter was inhibited by a series of factors and few significant advances in aviation are anticipated in the near future. Research and technology investments must be substantially increased in the remainder of this decade if the national well-being is to be served by significant advances in aeronautics in the years 1980 to 2000.

# Monthly NASA Highlights

## National Hispanic Heritage Week

The Congress of the United States, by joint resolution approved Sept. 17, 1968 (82 Stat. 848), requested that a period in September be annually designated in recognition of men and women of Hispanic origin. This resolution has been implemented by a Presidential Proclamation for the past three years.

NASA headquarters commemorated National Hispanic Heritage Week during the week of Sept. 13-17, 1976, and developed a special program for this event in conjunction with the DHEW's Office of Education.

The Hon. Thomas Aranda, Special Assistant to the President on Hispanic Affairs, was the keynote speaker at the opening ceremonies on Sept. 13. Dr. Arturo Morales Carrion, President of the University of Puerto Rico, was a guest speaker. Special events included traditional Hispanic music and folk dances, sampling of regional foods, a demonstration of an Hispanic bilingual theater, a symposium on Hispanic community organizations and a showing of the film "Tapestry."

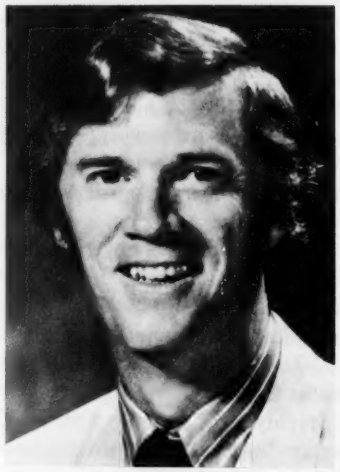
**Hispanic Fandango**—The Ballet Folklorico, folk dancers from Mexico, highlighted Hispanic Heritage Week activities held at the Johnson Space Center. Dressed in traditional costumes, the entire troupe performed a dance from Vera Cruz.

## Rusty Schweickart in New Job at NASA

Russell L. (Rusty) Schweickart has been named assistant for payload operations, reporting to the Assistant Administrator for Planning and Program Integration.

Schweickart came to NASA in the third astronaut selection in 1963 and flew the first lunar module on Apollo 9 in March 1969. In May 1974, he joined NASA headquarters as director of user affairs in the Office of Applications. In that capacity he was instrumental in providing a focus on the use of space in the solution of many terrestrial problems and in bringing an understanding of the needs of those users to NASA as they affect operations planning.

Schweickart's primary responsibility is to assist in the formulation of policy and plans for Shuttle payload operations. He is aware of user needs and desires and is personally familiar with manned space flight operations, qualities that uniquely fit him to contribute to this critical area.



## NASA Co-Sponsors Biomedical Instrumentation Conference

Medical experts from NASA headquarters and the Johnson Space Center, and NASA Biomedical and Technology Applications teams represented NASA at a biomedical instrumentation conference held recently at the University of Connecticut health center. The conference sought to acquaint manufacturers of biomedical instruments with technology developed by NASA for the manned space program that might be used to develop improved commercial medical equipment and techniques. NASA experts described the types of technology available to industry and the medical community and the role NASA can play in helping to commercialize new products.

## Nickel-Zinc Batteries Studied

Space technology applied to a nickel-zinc battery may eventually help reduce this nation's petroleum consumption.

Recent tests conducted by NASA's Lewis Research Center demonstrate that nickel-zinc batteries are able to provide almost twice the mileage range of conventional lead-acid batteries, thereby making them extremely desirable for use in electric vehicles.

Engineers tested the battery in an Otis P-500 utility van, a vehicle modified to be powered by electricity, using the battery space and battery weight equivalent to the conventional lead-acid battery. Tests revealed that the nickel-zinc battery delivered almost twice as many stop-and-go driving cycles per charge as the lead-acid battery.

A properly designed four-passenger electric car using the nickel-zinc battery is estimated to have a maximum daily range of 120 miles per day compared to only 60 miles when conventional lead-acid batteries are used. Lewis is conducting further studies to improve the nickel-zinc battery's life, performance and competitive cost.

## Participation in AGARD Conference

The 12th Annual Meeting of the Advisory Group for Aerospace Research and Development (AGARD) was held in Istanbul, Turkey, on Sept. 15-17. The mission of AGARD is to coordinate aerospace research and development for the common benefit of NATO member nations. At AGARD's request, Dr. William Schneider, Deputy Associate Administrator for Space Flight, made a major presentation on the Space Shuttle program at the Plenary Sessions on Sept. 16. Dr. Alan Lovelace, U.S. National Delegate from NASA, attended the 41st AGARD delegates board meeting, also held at that time.

## NASA-Industry Viking Team Receives Award

The NASA-Industry Viking Team was selected to receive the Air Force Association's Theodore von Karman Award. The Association called the Viking program "one of the most striking technological achievements in the history of science." Jim Martin, Viking Project Manager, accepted for NASA, and Tom Pownall, Executive Vice President, Martin-Marietta Corp., accepted for industry.

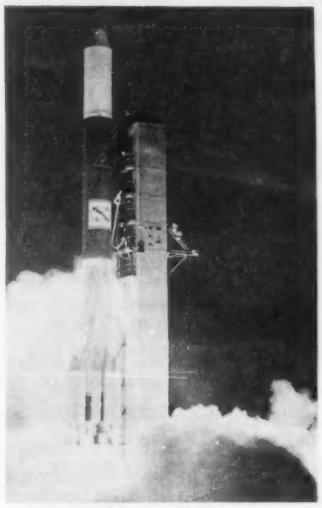
## Another Marisat Is Launched

The third maritime satellite (Marisat) was launched by NASA for COMSAT General Corp. from Cape Canaveral on Oct. 14 on board a Delta rocket. The communications satellite was placed into synchronous orbit over the equator at 73 degrees E. longitude.

Two other Marisat satellites now stationed over the Atlantic and Pacific Oceans are providing communications to the U.S. Navy, as well as to the commercial shipping and offshore industries.

The Navy will increase its use of Marisat by leasing UHF capacity in the third Marisat, which is to be positioned over the Indian Ocean.

The first Marisat spacecraft launched successfully last Feb. 19, is in orbit over the Atlantic at 15 degrees W. longitude. The second, Marisat-2, was launched June 9 and is in orbit over the mid-Pacific at 176.5 degrees E. longitude. The spacecraft were placed in orbit by Delta launch vehicles from Cape Canaveral, Fla.



**Launch of Marisat-3**

Both in-orbit spacecraft provide communications services to the Navy as well as full-time commercial voice and data communications to the maritime industry. Initially, Marisat-3 will be used only by the Navy.

At its altitude of some 36,000 kilometers (22,300 miles), the speed of the spacecraft in orbit matches the rotational speed of the Earth so it hovers over the Earth's surface. Small gas jets on board keep the spacecraft on station and oriented properly toward Earth to receive and retransmit signals. From this vantage point the satellite can serve an area of about one-third of the Earth's surface.

COMSAT General, which will reimburse NASA for the cost of the launch vehicle, launch services and other administrative costs, arranged for all ground station support required for the launch and control of the satellite. There are no requirements for NASA ground station tracking or command support after separation from the launch vehicle.

The Delta project is managed for NASA's Office of Space Flight by NASA's Goddard Space Flight Center; the Kennedy Space Center is responsible for launch operations. Prime contractor for the Delta rocket is McDonnell Douglas Astronautics Co., Huntington Beach, Calif. Prime contractor for the Marisat spacecraft is Hughes Aircraft, El Segundo, Calif. ■■■

## Renowned NASA Scientist Dies

The recent death of Dr. William Nordberg, 46, saddened numerous colleagues and friends throughout the space agency. Associated with NASA for 17 years, he was director of applications at the Goddard Space Flight Center from 1964 until his death, of cancer.

An Austrian by birth, he won his bachelor's and doctor's degrees in physics at the University of Graz, Austria. After he came to the United States in 1953, he worked for the U.S. Army Signal Corps at Fort Monmouth, N.J., as an atmospheric physicist. Later he became project scientist on the International Geophysical Year rocket program and on the Vanguard II meteorological satellite.

Nordberg moved to the Goddard center in 1959 as a member of a group of Army scientists transferred into the newly-formed NASA. His first post was as chief of the physical measurement section, meteorology branch, in the Satellite Applications Systems Division. As he gained experience, he was given progressively greater responsibilities in the space program. In time, he became a figure of towering importance in rocket and satellite experiments dealing with meteorology and the structure of the atmosphere.

A pioneer in the investigation of the Earth and its environment through the use of remote sensing from satellites, Nordberg was a member of the early TIROS weather-satellite team. The TIROS research led not only to the development of instruments of great accuracy, but to the formation of another team—led by Nordberg—that developed instrumentation designed to map ocean rainfall and sea-ice on a global basis.

He successfully coordinated the design and use of several highly complex remote sensors installed on Landsat, the world's first satellite developed specifically to collect data on Earth's limited resources. During the first year of the Landsat operation, Nordberg coordinated the activities of 300 scientists from 38 countries, in a program whose purpose was to develop highly sophisticated investigative techniques and demonstrate how a spacecraft could successfully monitor changes in Earth's environment. Data were collected on agriculture, forestry, land-use classification, marine resources and oceanography, mineral and oil exploration, geology, water resources and environmental impact problems.

Nordberg's numerous scientific publications dealt primarily with exploration of the upper atmosphere and the practical applications of Earth observations from space.

In 1975, he received the William T. Pecora Award, as well as the Distinguished Service Medal, NASA's highest award. Both were given in recognition of Nordberg's outstanding contributions to the applications of remote sensing of Earth factors from spacecraft.

Other citations included NASA's Exceptional Scientific Achievement Award in 1965 and the Goddard Special Act awards in 1964 and 1966. The National Oceanic and Atmospheric Administration gave him a commendation in 1969 for planning the Barbados Oceanographic and Meteorological Experiment, a part of a Commerce Department global, long-range weather project.

A memorial service in honor of Nordberg was held on Oct. 10, at the Goddard center.

## Anderson Named Congressional Fellow

Dr. Alvin F. Anderson, head of the Langley Research Center's office of research grants and university affairs since 1975, was selected for the 1976-77 Fellowship in Congressional Operations Programs.

Anderson is a graduate of Seattle University (A.B.), John Carroll University (M.A.) and the University of Virginia, where he received his doctorate. He was assigned to Langley in July 1972 to head the first full-time Office of Equal Opportunity Programs. As a licensed professional counselor in the Commonwealth of Virginia, Anderson has had varied experiences in higher education, and has received numerous awards and citations for his community and professional activities.

Federal executives selected for these fellowships study and learn how the Congress functions. They attend seminars, meet with representatives of different professions and interest who are in daily contact with the Congress, and spend a major part of the fellowship year (November through the following September) in Congressional offices or on Congressional committee staffs. The program is conducted by the American Political Science Association.

## Monetary Awards Program Continues Growth

NASA's Inventions and Contributions Board, which administers the program for the granting of monetary awards for scientific and technical contributions as authorized by Section 306 of the Space Act, has announced that FY 1976 was the most productive year in the history of the program. A total of $147,175 in monetary awards was recommended by the Board and subsequently granted during the year that ended on June 30, 1976. Of this amount, $74,425 was granted to employees of NASA, and an almost equal amount—$72,750—was granted to NASA contractor employees and to a foreign contributor.

The objectives of the program are to provide official recognition of, and to grant equitable monetary awards for, those inventions and other scientific and technical contributions that have helped to achieve NASA's aeronautical and space goals in the past, and to stimulate and encourage the creation and reporting of similar contributions in the future. A graphic measure of the success that has been attained by the monetary awards program is the fact that, with the addition of the amount of $147,175 granted in FY 76, a grand total of more than $1,187,000 in monetary awards has been distributed by the board since the first major award was granted in 1961.

**Space Programs Explained**—Civil Air Patrol cadets from 17 states and Puerto Rico recently spent four days at the Marshall Space Flight Center as participants in a space flight orientation course. The 44 cadets, who were accompanied by Air Force and Civil Air Patrol officers, toured various laboratories and attended lectures by NASA scientists and engineers. Here, Marshall's Ruth von Saurma (second from left) talks about a Skylab model with Cadet Edwin Cruz of Puerto Rico (left), Cadet Lorraine Swift of N.Y., and Lt. Col. Charles R. New.

## Heyman Invention Receives Industrial Magazine Award

An instrument developed by Dr. Joseph S .Heyman, called an "Ultrasonic Bolt Stress Monitor," has been selected as one of the 100 most significant new technical products of the year in the 1976 IR-100 competition, sponsored by *Industrial Research* magazine. Heyman is a physicist at NASA's Langley Research Center.

The IR-100 winners were honored at an awards banquet at the Museum of Science and Industry in Chicago, which marked the opening of a six-week exhibition of the new products to scientists, engineers, educators and the public.

Heyman, who specializes in ultrasonics, recognized the need for a relatively inexpensive system for measuring the strain in bolts. His investigations revealed that the torque wrench is a widely applied technique for stress bolts, but that friction in the bolt threads and between the nut and the work lead to inaccuracies in the method.

Other more accurate means for tightening bolts and measuring strain exist, but they can be very expensive and complex, or they may be permanently connected to the bolt. They make it impractical or impossible to monitor a multitude of bolts in a facility or piece of equipment.

Heyman's ultrasonic bolt stress monitor has the advantage of being portable, easy to use, inexpensive and accurate. By using a new ultrasonic instrument, called a reflection oscillator ultrasonic spectrometer, changes in bolt strain can be measured to better than one part in 10,000. The instrument indicates a shift in the bolt resonance frequency because of elongation and changes in velocity of sound caused by strain.

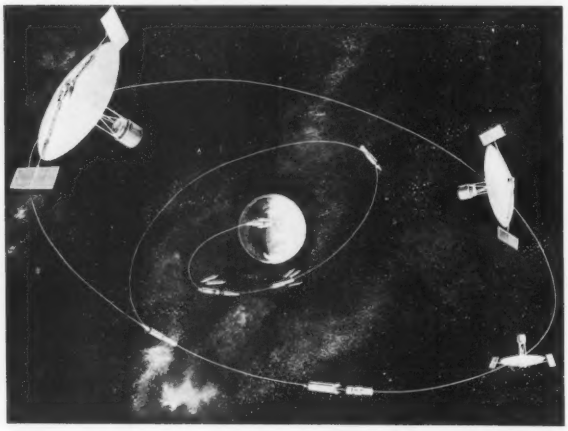
**Cheaper, Easier Method to Measure Stress and Strain**—Dr. Joseph S. Heyman, an ultrasonics specialist at Langley, demonstrates his award-winning Ultrasonic Bolt Stress Monitor.

## ATS-6 Coming Home

The world's most advanced communications research satellite is returning to the United States after a year-long cooperative experiment with the Indian Space Research Organization (ISRO). The program was designed to evaluate the role of television by satellite in promoting rural development there.

NASA's Applications Technology Satellite-6 (ATS-6) began the four-month journey westward Aug. 2 from a station over Lake Victoria in East Africa, in view of the Indian continent. Its move was commanded from the ATS control center at NASA's Goddard Space Flight Center, through a mobile ATS ground station near Madrid, Spain.

For the Indian test, called the Satellite Instructional Television Experiment (SITE), special programs developed in India were broadcast daily from a ground station near Ahmedabad, India, to the ATS-6 satellite overhead. Serving as a powerful rebroadcasting station in space, the satellite automatically relayed the instructional television programs directly to some 2,400 remote villages whose people had never before been exposed to television. The villages were equipped with small ground terminals consisting of conventional television receivers augmented with small electronic components and inexpensive chickenwire mesh antennas, all built in India.



**Communications from Space**—How an artist sees the ATS from launch to deployment in orbit. The spacecraft configuration consists of a nine-meter (30-foot) diameter deployable antenna and a precision control system. The antenna is folded into a tight package pre-orbit, then deployed to full size.

India's conventional television stations also were equipped with the small ground terminals for direct reception from the ATS-6. These stations rebroadcast the educational material to some 2,600 nearby cities and villages.

An estimated five million people throughout India viewed programs dealing with such basic subjects as agriculture, health, hygiene, family planning and national integration. Other programs dealt with science for youth and teacher education.

"One year of experimental television is not going to change the face of our villages. But it has had many wholesome effects and it has met its primary goal of creating a cadre of dedicated people and the methodology necessary to sustain an ongoing program," said Prof. Yash Pal, Director of ISRO's Space Applications Center in Ahmedabad.

The Indian government is currently constructing ground transmitters in the six cluster areas to resume the educational television programs by early 1977. Because of their limited range, the transmitters will reach only about 40 percent of the villages involved in SITE, but other villages near the transmitters will be added to the audience. ISRO is also defining an operational satellite system for the entire country which could be implemented later in this decade.

A comprehensive evaluation plan, initiated by ISRO before the broadcasts and sustained during and after them, is expected to produce a comprehensive analysis of SITE by mid-1977. That analysis presumably will illuminate the role of television in providing services to Indian villages in agriculture, health, family planning and primary education.

**Rapt Audience**—Villagers from Rajasthan (India) watch SITE programs beamed to their village courtesy of NASA and the Indian Government. Health and education programs were emphasized during a one-year experiment.

More than 1,200 hours of diversified programs were developed and broadcast via the ATS-6 during the recent experiment, more time than has been devoted to the large annual production of Indian feature films.

According to Prof. Pal, there was a great demand for programs containing simple, do-it-yourself tips leading to practical solutions. Programs related to animal husbandry and agriculture were extremely well attended.

Before the year-long transmissions began, teams of Indian social scientists and engineers visited more than 6,000 villages to select 2,400 of them for SITE direct reception. An individual in each village had to be identified as the TV set caretaker and a public building, usually a school, had to be located as the viewing site. Only at a genuinely public location could the weaker sections of village society be assured of equal exposure to SITE television.

Considerable difficulty was experienced in locating appropriate villages because so many lacked electricity. Thus, a number of villages had to be supplied with power, an incidental and valuable side benefit of the experiment.

Numerous incidents noted during the year-long mission revealed some of the beneficial effects of the programming on the village people. Children's programs, for example, were received enthusiastically. School attendance improved as a result and many students brought along younger brothers and sisters to view the programs.

A boy in a village in Karnataka now insists that greens be added to his flour chappatis to make them more nutritious. The bread-like chappati is a staple food in India.

A teacher in Madhya Pradesh village said: "The children are keen to see moving images of places that they had only imagined until now. The geography lesson sinks in better this way."

After seeing a SITE program, a group of young men in Nandykeshwara moved a washing stone from near the community well and re-installed it some distance away for health reasons. No one bathes near the village now, to prevent dirty water from seeping into the well.

Programming for SITE was created by All India Radio (now Doordarshan) of the India Ministry of Information and Broadcasting in collaboration with ISRO. The programmers found it necessary to keep the program content and format simple due to the high rate of illiteracy among the adults. Only about 40 percent of India's children remain in school through the fifth grade.

The presentation of dental hygiene had to do more than explain why the regular brushing of teeth was a good health practice. A significant practical tip in the program was a demonstration of how to make toothbrushes from thin tree branches. Many of the villagers had never owned a toothbrush.

In a lesson on how to plant rice, the width of a man's fist was shown as the proper distance between plants. Use of inches or centimeters would have been meaningless.

The ATS-6 was launched May 30, 1974. It operates from a geosynchronous orbit, 35,680 kilometers (22,300 miles) above the equator. The orbital period for the 1,402-kilogram (3,090-pound) satellite around the globe matches the Earth's 24-hour rotation so the ATS-6 remains over the same spot until it is moved. It serves as a powerful rebroadcasting station in space, capable of transmitting color television directly to many small ground stations scattered over a large area.

SITE is but one of the 20 original communications, technological and scientific experiments conducted through ATS-6 facilities. Before the SITE mission, the satellite was used to perform a variety of health and education television experiments via satellite in the Appalachian area, the Rocky Mountain region and northwest United States, including Alaska.

**Modern Technology at an Ancient Site**—Antenna installation atop a schoolhouse in the Indian village of Rajasthan makes possible receipt of television transmissions from the ATS-6, positioned over the eastern edge of Lake Victoria (Kenya), at an altitude of some 35,881 kilometers (22,300 miles) above the equator.

Other experiments included aeronautical and maritime communications, traffic control and position location as well as spacecraft tracking and data relay.

In July 1975, while it was being shifted eastward along the equator for the SITE mission, the ATS-6 tracked the docked Apollo and Soyuz spacecraft as they orbited the Earth in the joint U.S./U.S.S.R. manned space mission. It also relayed live television from the two spacecraft to the Earth, thus becoming the first satellite to perform such a feat.

During its current four-month movement back to the United States, the ATS-6 is being used in a demonstration of how space and other advanced technology can be used to benefit the people of developing countries. The effort is a joint undertaking by the Agency for International Development and NASA.

On Aug. 1, the three-month demonstration started illustrating how the application of space communications, remote sensing and high-resolution aerial photography can help with food production, health and nutrition, and land management.

Twenty-nine developing countries in Asia, the Middle East, Africa and Latin America are participating in the project. AID provided $3 million to finance the demonstration.

After the ATS-6 reaches its new position, it will be used for a variety of societal, communications and scientific/technical experiments in the continental United States and Hawaii.

**People Watcher**—A young roseate spoonbill recently took a leisurely self-guided tour around the grounds of buildings 1 and 2 at the Johnson Space Center. The avian visitor was unperturbed by human passersby and photographers.

## Distinguished NASA Officer Resigns

*Editor's Note: Ruth Bates Harris, the only woman to reach the rank of Deputy Assistant Administrator of NASA and NASA's first director of EEO, resigned from the agency Oct. 15, 1976. Harris, whose efforts helped break ground for equal rights for minorities and women, returns to her professional base in New York City on her departure from NASA. She contributes this farewell message:*

"To all members of the family NASA:

"Gee, but it is difficult to leave you! By the time you read this letter, you already will have heard that I have returned to New York to attend to pressing personal family needs.

"Please believe that I have very mixed emotions about leaving, deeply indebted to each of you as I am.

"You gave me greater insights into the contributions that NASA is making to the health, welfare, safety, comfort and tranquility of peoples all over the world.

"You helped me to grow in my profession by providing continuing opportunities for diversified experience and education.

"You bolstered my courage to do what needed to be done for the general good without desire for personal gain.

"You helped me to improve in such qualities as tolerance, compassion, empathy and humility.

"Above all, you helped me to strengthen my faith in God and all of His children.

"My resignation becomes effective Oct. 15, but for a few months afterward I will be working with Bob Newman and NASA in a consulting role to take care of some unfinished Community/Human Relations Projects.

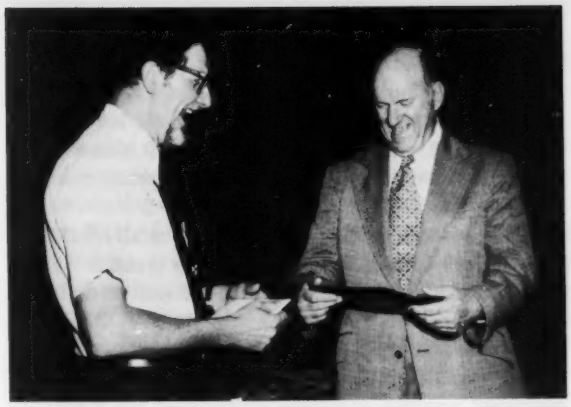
"My personal thanks to our Administrator and his team for the privilege of being a public servant in an agency whose contributions in aeronautics and space and advanced technology benefit all humankind. May God's wisdom oversee each of us as we plan for the future."

## Brunner Wins $4,000 Award

Louis Brunner, Chief of the data systems section, plant engineering division, at the Langley Research Center, recently received a $4,000 invention and contribution award for his "Computerized Construction Specification Systems (SPECSINTACT)." The Brunner contribution consists of 15 volumes of text on one computer tape containing construction specifications.

The computerized system took Brunner five years to complete and involved writing, compiling, editing and coding all specifications for the computer.

The system was put to use beginning in early 1970 and has been a part of about 350 projects to date. It has been used by almost all the NASA centers, for jobs ranging from a small painting job to large constructions for the Viking project at KSC. The construction agency of the State of Illinois is only one of several organizations outside NASA which has expressed an interest in the system.



**Data Chief Awarded $4,000**—Louis Brunner (right) is presented with an invention and contribution award by Langley director Donald Hearth. When asked what he plans to do with the award money, Brunner laughed and said, "pay some bills." He noted that, although he was given the award, his wife was given the $4,000 check.

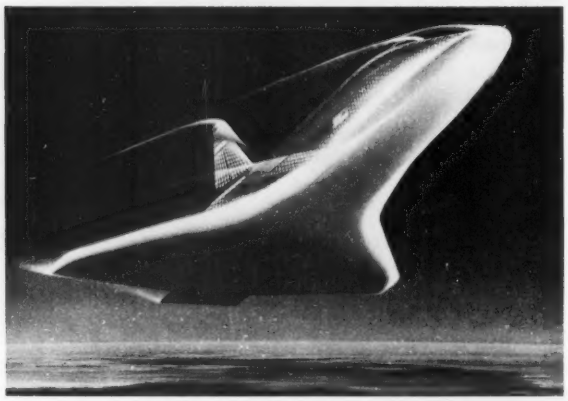
**Shuttle Review Tour**—Gilbert W. Keyes (center), director of the staff of the Senate Committee on Aeronautical Space Sciences, completed a two-week review tour of the Shuttle program with a visit to the Marshall center recently. Accompanying Keyes on a tour of Marshall center facilities and explaining the operation of the Shuttle acoustic test stand were Richard G. Smith, MSFC deputy director; Judith Ann Cole, deputy assistant administrator in NASA's Office of Legislative Affairs; Keyes; Leland F. Belew, deputy director of Science and Engineering; and Stanley R. Reinartz, director of test lab.

**Hoosier Is 10-Millionth Spaceport Visitor**—David Perry of Hanover, Ind., vacationing in Florida with his wife and two children, recently became the 10-millionth purchaser of tickets to the guided bus-tour of the Kennedy Space Center. The tour program began in July 1966. After purchasing the historical ticket, the Perry family was escorted to the KSC headquarters building by NASA's Assistant Administrator for Public Affairs, Robert Newman (left). There the family members were welcomed by KSC center director Lee R. Scherer, who gave them an autographed photo of the space center and tickets to Third Century America, the nation's Bicentennial Exposition on Science and Technology, held this past summer at the Kennedy Center.

## Production Begins on Heat Shield for Space Shuttle

A space-age insulation that sheds heat so efficiently it can be held with bare hands while still red hot will be manufactured in great quantities at a new Lockheed Missiles & Space Co. facility, opened recently at Sunnyvale, Calif.

Refined from common sand, the unique all-silica material will be used as a heat shield to protect space travelers of the 1980s aboard the various craft that will make up NASA's Space Shuttle. At NASA-held ceremonies last Sept. 17 in honor of the rollout of the first Shuttle orbiter, a small patch of the Lockheed heatproof material had been installed on the underside of the *Enterprise*. Most of the visible tiles were simulations of the real thing.



**Shuttle Heat Shield**—Bricks of pure silica are seen in this artist's concept (drawn some three years ago) protecting NASA's Space Shuttle from intense heat that turns much of the underbelly white-hot during reentry into the Earth's atmosphere. Lockheed Missiles & Space Co. is making nearly 34,000 tiles of the unique material—in thousands of sizes—for upper and lower surfaces of each shuttle spacecraft.

Nearly 34,000 "tiles" of the Lockheed insulation will be used to cover about 70 percent of each spacecraft's surface.

The tiles are expected to survive temperatures up to 1,295 degrees C. (2,300 degrees F.) for 100 flights, with only minor maintenance. It is this feature that makes the Shuttle a truly reusable—and economical—space transportation system. Previously, all manned spacecraft used a heat shield that was destroyed during each fiery reentry into the Earth's atmosphere.

Lockheed's new 3,956-square meter (43,000-square foot) production facility houses the very latest in high-temperature kilns, automated spray-coating equipment, computerized inspection and test systems, and numerically-controlled milling machines.

According to Dr. Kevin J. Forsberg, Lockheed's Thermal Protection System program manager, production of flight-quality tiles will begin almost immediately and peak production levels of 5,000 tiles per month should be reached early next year.

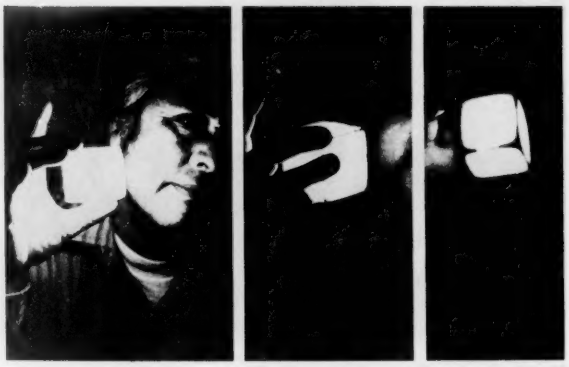
Each tile on the spacecraft will be precisely milled to match the curvature of the Shuttle's surface at the exact point it is to be attached. (The tiles carry code numbers to indicate where they will be placed.)

This reduces overall weight of the insulating system and assures aerodynamic smoothness, but it also means no two of the 34,000 tiles in a shipset are exactly alike. Further complicating assembly, tiny gaps must be left between tiles to allow air inside to escape on orbit, and those gaps must be uniform to within 20 one-thousandths of an inch—a very small margin for error.

All this makes the task of fitting tiles together on the spacecraft's skin somewhat like assembling the world's largest three-dimensional jigsaw puzzle on a surface twice the size of a basketball court.

To simplify milling and assembly chores. Lockheed has developed an "array" concept in which groups of 20 or more tiles will be placed in a frame and locked together in their precise positions for final machining and attachment to the Shuttle.

Lockheed's contract with Rockwell International includes options for five complete shipsets of tiles. (The first Shuttle, however, will not be insulated until after preliminary, non-orbital flight tests are completed.)



**White Hot, and Fresh from a 1,295-Degree-C. Oven**—The glowing silica cube provides the only illumination in this photograph as a technician from Lockheed Missiles & Space Co. holds it in his bare hand without injury or even discomfort. The demonstration illustrates the remarkable speed with which heat is cast off by a unique silica insulation that Lockheed is manufacturing for NASA's Space Shuttle. The photo was taken less than 10 seconds after the cube was removed from the oven.

Those first five spacecraft—excluding spares—would require more than 165,000 individual tiles, enough to consume approximately 7,000 cubic feet of raw material and cover more than an acre of land.

Although the tiles will be cut into hundreds of unusual and complex shapes for special areas of the Shuttle, most will be either six or eight inches square and differ only in thickness and the curvature of their surfaces.

All are made from the same silica-based formula, but two different types of coatings will be applied. For the Shuttle's entire underside and some small areas on top where temperatures will reach 675 to 1,295 degrees C. (1,200 to 2,300 degrees F.) a black reaction-cured glass coating will be used. For areas in the 343 to 675 degrees C. (600 to 1,200 degrees F.) range on sides of the tail section, engines, fuselage, and on top of wings near the front edge, a white silica compound coating will be applied. Shiny alumina oxide will also be added to better reflect the Sun's rays and keep the Shuttle cool on orbit.

A waterproofing polymer will then be put on each tile to prevent its absorbing moisture—and weight—from rain or humidity between missions.

At the time of assembly, a felt strain-isolator pad—similar to the covering on a tennis ball—will be added to the bottom of each tile and then bonded to the Shuttle's aluminum surface.

During peak periods of production at Lockheed, company estimates are that tile manufacturing and the fabrication of array frames will employ more than 400 people.

**Management Award Winner**—Todd Groo, Associate Administrator for Center Operations, presents a $1,000 superior achievement award to Richard Mulligan, assistant director of the Office of Management Evaluation and Analysis. The award recognized Mulligan's excellent management of the NASA productivity program.

## Filtering Out Television Noise

Chief James C. Stamps of the Johnson Space Center's television office recently was given a $1,500 cash award for his part in developing a television noise-reduction device used during the Skylab and Apollo Soyuz missions.

Stamps and Bernard L. Gordon, formerly a Taft Broadcasting contract employee, split a $3,000 award given by NASA headquarters in recognition of their work in solving a problem that had bothered NASA television reception since color video was first used on Apollo 10. Work on the corrective device began in 1969 and it was made operational in 1973. A patent was issued in 1975.

What Stamps and Gordon built was a new system to improve the signal-to-noise ratio in color-TV video signals. Color-TV video signals transmitted in noisy environments (as from space) in earlier years caused poor images, and standard filtering techniques to reduce the noise usually decreased picture resolution.

Essentially, the Stamp-Gordon device separates the incoming color video signals into luminance (black and white) and chrominance (color) components. The black-and-white signal is recorded on a disk recorder up to a total of four TV frames. The frames then are summed and averaged, reducing the random noise and returning the basically repetitive television signal to its original strength. The color signal is added back to the new black-and-white signal and the result is a noise-reduced television signal.

**Award Winner**—James C. Stamps checks over the equipment that won him a $1,500 cash award. The color TV noise reduction device developed by Stamps and former contractor employee Bernard L. Gordon solved a problem that had plagued NASA color TV reception for years.

## Prospectus

*Tracking and Data*

No airliner traverses this country without constant communications with FAA air controllers, airports and other ground support units. In raising flight to its ultimate degree, into space—NASA has established a similar and much more complicated system. Long before the agency began to fill space with manned and unmanned vehicles and satellites in the 1960's, it had established major communications facilities on Earth.

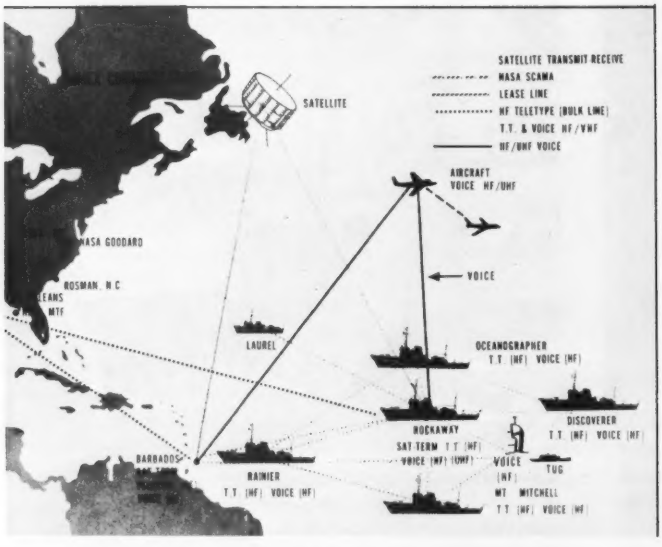
They included the Manned Spaceflight, the Satellite Tracking and Data Acquisition and Deep Space Networks. More recently, a resourceful and hard working systems-support team consolidated the first two nets into the current Spaceflight Tracking and Data project. The program evolved the first R&D 64-meter antenna at Goldstone, Calif., into a fully operational high-power control facility, with the addition of similar antennas in Spain and Australia.

Overseas, NASA encountered a host of problems in establishing its operations. From 1969 on, the agency was faced with strikes, inflation, peculiar local labor practices, the devaluation of the dollar and other stumbling blocks seemingly without end. The NASA managers and employees saw it through on schedule and within budget. Today, we track and communicate with spacecraft investigating both the near and, in the case of Viking, the far out bodies in the planetary system.

All of these missions are sending down data and pictures which must be digested by large computer systems in various parts of the globe. The Goddard Space Flight Center near Washington is the nerve center for worldwide tracking and communications. At nearby Suitland, Md., an installation of NOAA—the National Oceanic and Atmospheric Administration—computes the findings of weather and environmental satellites. Information on crop management goes to the Johnson Space Center at Houston.

Success stories, however, seldom happen without complications. A principal concern of NASA today is the volume of transmission that grows from its own capabilities. The Dutch people assiduously tend their dikes or a major part of their land would shortly be under the North Sea. In similar fashion, the space agency must exercise rigid control over the incoming data from its orbiting satellites. NASA headquarters, in conjunction with the centers, is planning and working every day to maintain a stable situation.

The continuous functioning of the Landsat operation alone gives an indication of the difficulty. Two of the earth resources satellites are in alternating circular near-polar-Sun-synchronous orbit, some 500 nautical miles high. Each Landsat makes a complete orbit of the Earth every 103 minutes and each completes 14 orbits every day. Therefore, both satellites are scanning the entire Earth every 18 days.




**Complex Communications Network**—This diagram shows how the Barbados Oceanographic and Meteorological Experiment of 1969 was conducted. A wide variety of communications devices and platforms were used, including ships, aircraft, a satellite and ground stations. Participants were from government agencies, university organizations and private industry.

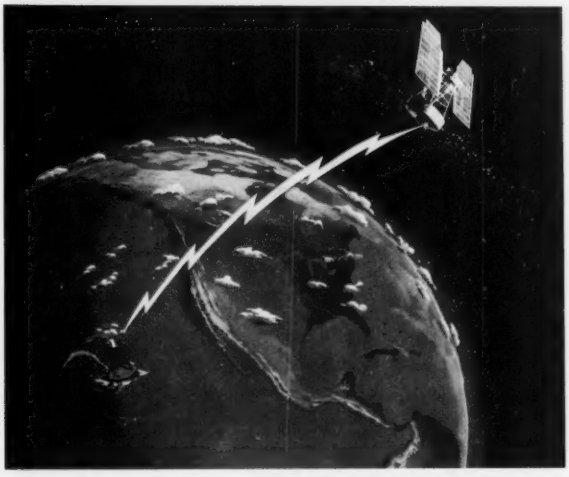
The Library of Congress houses 16 million books and pamphlets. One current four-band multispectral scanner image on a Landsat produces the equivalent of one Library of Congress every nine years, or considering two satellites, every four and one-half years. When Landsat C is launched, it may carry a thematic mapper, whose seven bands would so contribute to the volume of the system that Earth would receive what amounts to 16 million volumes every three months

The Jet Propulsion Laboratory predicts that by the year 2000, space imagers may be returning the equivalent of 3,600 Libraries of Congress a year. Some program managers at NASA call it a potential data "glut." Such a flood of data may remind the three generations of people who saw Disney's "Fantasia" of a technological version of the Sorcerer's Apprentice.

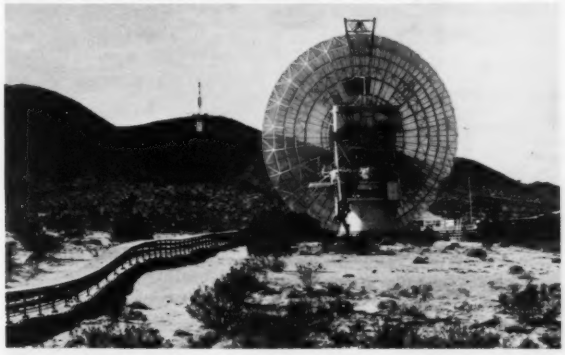
Obviously, NASA must build its capacity to absorb all of the information. This is already in process at both Goddard and Houston. The data banks are rapidly being modified and improved, as are retrieval systems and storage.

Another solution is to improve the processing operation aboard the spacecraft itself, with the scanner system discarding unwanted material and compacting the rest. To date, storage systems for flight have relied on magnetic tape, drums and discs. Through developments such at the multi-track, long-duration tape recorder, scientists have stepped up the ability to store for access in flight a small library up to 2,000 books. A bit further downstream, NASA officials will have learned to discriminate in controlling the ocean of information and will select only what is needed.

Data-gathering and dissimination also will be faster. The goal is a 1,000-fold increase in the capability of space systems at a reduced cost. This is converting 1,000 times more bits of raw data to useful information for the user in real time, or close to it. NASA is building an experimental device using a combination of charge-coupled and large-scale integrated circuit technologies. During FY 1977, personnel will integrate the processor with supporting electronics and evaluate its performance with recorded data. When fully developed, the programmable data processor will provide the flexibility required to support a wide variety of onboard data reduction. Once that happens, the user can obtain his information in near real-time.



**Tracking Earth Features**—A Nimbus satellite launched in 1969 not only collected weather information, but was used to record data from Earth platforms such as moored and floating buoys, balloons, an ice island, fixed land sites, hurricane hunter aircraft and air-sea rescue aircraft.



**Dishing up Electricity from Space**—NASA's Goldstone Tracking Station near Barstow, Calif. is ordinarily used to communicate with interplanetary spacecraft. The so-called Venus dish is now serving also as a research tool to study the problems involved in beaming converted solar energy from a satellite in space back to Earth, where it can theoretically be reconverted into electricity. For the tests, the 25-meter (85-foot) high antenna represents an energy satellite. From its vantage point in space, it would collect and convert sunlight energy into electricity. A mile away, a 7½-m. (25-ft.) high aluminum unit consisting of receiver panels plays the part of a ground station. The panels work like a television antenna, gathering and filtering the microwave energy and converting it to alternating or direct current that could be fed directly to a utility. Goldstone researchers say that their experiments so far have collected microwave beams and converted them to usable electricity with an efficiency rate of 82 percent.

## Prospectus *(continued)*

NASA cannot send into space technology uncontrolled from the Earth. One of the great dramas of manned spacecraft missions was not only knowing where the astronauts were and where they were going, but also the light from consoles and the concern reflected on the faces in Mission Control. Our ground networks have fully demonstrated that they can handle the eventful years ahead, and make adjustments on spacecraft millions of miles away. The imagery of the National Aeronautics and Space Administration is—as it must be—that of the complete professional. ■■■■

**Outfitted for Space Travel**—Astronaut John W. Young is not demonstrating "The Hustle," but checking the comfort and mobility of a new kind of space suit. The suit, developed at the Johnson Space Center, is a two-piecer, with upper and lower torso sections joined by a waist seal closure instead of the slide fasteners used on earlier suits. Suits are produced in small, medium and large to fit a wide range of sizes. Young is chief of JSC's astronaut office.

## NASA to Seek Student Involvement in Space Shuttle Experiments

Reporting that NASA is developing a program whereby high-school and college students will propose experiments to be flown in the Space Shuttle, Senator Frank E. Moss said:

"Encouraging students to propose experiments for the Space Shuttle will provide a pool of innovative ideas for NASA and also will stimulate student interest in our space programs." Moss is chairman of the Committee on Aeronautical and Space Sciences, which overseas the nation's space programs.

In a letter to NASA last September, Senator Moss asked the agency to consider a student experiments project, noting that the earlier Skylab student project was a success. Hundreds of high school students proposed experiments to be flown on Skylab, and 19 actually were flown on the three missions in 1973.

"The advent of the Space Shuttle, with its projected routine and frequent flights, and sharp reduction in payload costs and lead times for preparation, should allow for greater participation of students at all levels," Moss noted in his letter.

He also said that the Federation of Americans Supporting Science and Technology (FASST), a national organization, is attempting to develop a continuing relationship between students and NASA and has obtained support from many scientific and technical societies with student members.

These interested students, Moss said, have been hampered by the lack of an organization or person within NASA that could proceed with development of a student space experiments program. In a reply to Senator Moss' letter, Dr. James C. Fletcher, NASA Administrator, said that Herbert J. Rowe, Associate Administrator for External Affairs, will be responsible for developing student programs and coordinating with student groups.

"NASA currently is considering development of a program in which contractors would be selected to conduct nationwide competitions for both secondary school and college students and their instructors/faculty advisors," Fletcher told Senator Moss.

These competitions would be widely advertised, and winning proposals would be presented to NASA for final screening and selection, Fletcher said.

"As the Shuttle program advances into future years, it is possible that outstanding students would be selected to serve as actual payload specialists aboard Space Shuttle missions," he told Senator Moss.

"I am very pleased with NASA's response to my request," Moss said. "High-school and college science students can and should play an important role in space science after the Shuttle becomes operational in 1980."

# Did You Know?

**"Historical Highlights from Space,"** a 36-minute tape cassette with the actual sounds and voices that highlighted events of space exploration from 1958 to now, is available from the National Space Institute, P.O. Box 31251, Washington, D.C. 20031. The cost is $3.50 (check or money order).

NSI is a non-profit scientific and educational organization. Its chairman of the board is Dr. Wernher von Braun. Hugh Downs is president. Downs narrates the tape, which begins with the telemetry from Sputnik 1 and covers major space milestones through the Apollo Soyuz Test Project. Von Braun summarizes the significance of U.S. space accomplishments to date.

**NASA's Marshall Space Flight Center** has awarded a contract worth $803,510 to SCI Systems, Inc., of Huntsville, Ala., for a contamination monitoring system for Space Shuttle flights. Contaminants can be many and varied, ranging from dust finding its way from crevices in the weightlessness of space to residue from attitude control rockets. Even the exhaled breath of an experimenter contains contaminants, such as water vapor and other gases.

The contract calls for two units entitled "Induced Environment Contamination Monitoring System" to be flown in the Shuttle Orbiter's cargo bay. The first unit is to be delivered Sept. 1, 1978.

**The Johnson Space Center** has signed a $2.57 million supplemental agreement with the Lockheed Electronics Company, Inc., Houston, for additional scientific and technical support at the Slidell Computer Complex, Earth Resources Laboratory, at Slidell, La. The additional agreement brings the total value of the contract to $7.1 million.

**About 80 scientists from universities, medical facilities and industry** met in Huntsville, Ala., in July to evaluate experiments proposed for the first Spacelab mission. The evaluation was directed by the Universities Space Research Association. Results of the evaluations will be used by NASA's Space Science Steering Committee in selecting the experiments to be carried on Spacelab 1, currently scheduled for launch in the third quarter of 1980.

**An updated "Capsule History of Weather Satellites"** (#76-146) is now available from the NASA Newsroom (Code FP, Washington, DC 20546). Brief details cover all weather satellites from Tiros-1 in 1960 to NOAA-5 in 1976.

**The Sperry Rand Corporation** of Huntsville, Ala., has received a modification of an existing contract extending the period of performance for eight months, through March 31, 1977. The extension, valued at $3,479,844, is for continued engineering support services to the Marshall center's Science and Engineering Directorate.

**The Martin Marietta Aerospace Co.,** Denver division, has been awarded a contract by the Marshall center for the design, development, verification, manufacture and refurbishment of Space Shuttle solid rocket booster decelerator subsystems. The contract provides for the delivery of parachute decelerator subsystems for use in recovering 12 solid rocket boosters from six Space Shuttle flights.

**Minority business firms in 1976 received $2,265,727** in contracts awarded by the Johnson Space Center. The total surpassed JSC's target of $2.2 million, to be placed under the SBA Business Development Program. The center has awarded nearly $6.8 million to eight businesses since the beginning of the program.

**Since September 1975, more than 3,000 inquiries concerning solar energy developments** have been received at the Marshall center. According to a center representative, many have come from industries searching for a practical solar energy system for possible commercial marketing. Most, however, come from private citizens seeking an economical method of using the Sun's energy to heat and cool their homes. MSFC conducts various solar energy experimental programs for the Energy Research and Development Administration, carried out by its special projects and technology utilization offices.

**Minority institutions** were awarded 20 research grants totaling about $509,000 by the Marshall center during the 1976 fiscal year. The figure represents about 6.3 percent of the total $8.1 million dollars awarded by MSFC to colleges and universities across the nation for research projects relevant to MSFC roles and missions.

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## Two Newcomers to International Affairs

C. Jackson Pfeffer, a presidential interchange executive, has joined the Office of International Affairs for one year. Pfeffer comes to NASA from his most recent assignment with the Xerox Corporation as manager for planning and analysis of the office systems division in Dallas, Texas.

Pfeffer holds a B.S. degree from Southern Illinois University and an MBA from the Rochester Institute of Technology. Before joining the Xerox Dallas office in 1974, he held several key planning positions in the Xerox copier/duplicator business areas in Rochester, N.Y. From 1964-69 Pfeffer worked in the contract and program planning departments of McDonnell Douglas where he was active in assignments related to program control. He also worked in the F-15 aircraft program development.

During his presidental interchange assignment at NASA, Pfeffer will serve as special assistant to the Assistant Administrator for International Affairs. His primary assignments will involve economic studies of international participation in NASA's Landsat program.

Benjamin M. Zook recently became director of international programs policy, Office of International Affairs. Zook is with NASA on detail from the Department of State, where he was a specialist in aspects of Soviet and East European affairs from 1949 to the present.

A native of Memphis, Tenn., Zook holds a B.A. from Harvard University. He attended the U.S. Army War College, Carlisle, Pa., from 1969 to 1970. From 1943-46 he served as a paratrooper with the 11th Airborne Division in the Pacific area. In addition to Washington assignments in the State Department's Bureaus of Intelligence and Research and European Affairs, Zook served as an attache at the U.S. Embassy in Moscow (1952-54), and as a first secretary and head of the Embassy's Internal Political Division (1965-67). His last assignment was as multilateral affairs officer on the Soviet desk at State.

## NASA Veteran Recalls "Good Old Days"

*The Johnson Space Center's "Roundup" recently printed a nostalgic account of the way things were in 1961.*

Fifteen years ago, cattle grazed on the grassy 1,640-acre site where the Johnson Space Center is now located.

In September 1961, JSC photographer A. R. "Pat" Patnesky was working at Ellington AFB. He was asked to drive out to Clear Lake and take pictures of the newly selected NASA site.

The accompanying "Cow picture" has been published numerous times and has been shown to visiting dignitaries to illustrate what the area was like before construction.

Here is Patnesky's own story about how that photo and others came about. He recalls:

"I'd been down in this area before, driving past it, going to Seabrook or something like that, but at the time when you went by the site of the space center, you were just out in the country. NASA Road 1 was just a two-lane road.

"Where Nassau Bay and environs are now was nothing but trees till you came around where the LSI is now and you'd see the lake. On the left was an old mansion. You didn't have these trees. It was grazing land.

"NASA needed pictures of all the structures that were on the site that were going to be removed. . . . They just wanted to see what it looked like . . . probably for artists' concepts.

"I drove out in a government car. In the back there was a farmhouse—down by the mansion—and nearby there was an old road that went in back by the woods. You could drive over the old farmer's wagon trail.

Texas Cows

Windmill

"The windmill was out toward the present back gate. That large shed was near the astronauts' gym. There were three or four bridges, little old wooden things.

"I was looking for these things. You could see the buildings but when I'd go along these little farmers' trails and find the bridges I'd get out of the car and go shoot them.

"I saw two or three snakes and there were plenty of jackrabbits. Of course there was deer here. There still are.

"The cows gave me a hard time. It took me about an hour to shoot their picture—the way they were standing. I wanted them to look at me.

"I just stood out there and waited and waited. Several times I even 'mooed' to get their attention. Like they say, you need patience.

"I spent at least four or five hours shooting these pictures—most of the time waiting."

Shed

## Three NASA-Developed Products Called Outstanding

Three products developed at NASA's Lewis Research Center are included among *Industrial Research* magazine's list of the 100 significant products developed during the past year.

The three products are: a continuous production cyclotron target developed by Dr. James W. Blue of Lewis; thickness measuring radar developed by Dale W. Cooper and John Heighway of Lewis and Dr. Roger S. Vickers of Stanford Research Institute; and ceramic thermal barrier coating developed by Stephan Stecura, Curth H. Liebert and Jack E. Brown of Lewis.

The continuous production cyclotron target is used for producing radioactive xenon isotopes to provide radio pharmaceuticals for diagnostic nuclear medicine. The xenon 127 produced by the target can be used in studies of lung ventilation and lung perfusion. During one process, after gas has been inhaled by a patient, measurement shows the extent to which the airway passages are open. In another process, the isotopes can be injected intravenously to reveal pulmonary circulation via gamma camera image.

According to the developer, the widespread availability of iodine 123 from this xenon decay will lead to its use in most thyroid studies, with a significant reduction in exposure of a patient to radiation, as well as to improved quality of images.

This new target exceeds the performance of previous targets because radioxenons are removed continuously from the target, yielding as much as 100 percent gain over comparable irradiations.

The thickness measuring radar was built to measure lake ice thickness directly beneath an overflying aircraft.

The system is presently being used by the U.S. Coast Guard to aid in extending the shipping season on the Great Lakes. Such extension can save millions of dollars in shipping ore and coal.

Before the new system was developed, on-the-surface ice auger teams were used to measure ice thickness, but their measurements were necessarily on a limited scale and on an irregular basis.

Ceramic thermal barrier coating is designed to create a thermal barrier between very high-temperature erosive and corrosive gases and cooled metal parts. Its action significantly reduces the metal temperature, thereby substantially increasing metal life.

Lewis Center developers subjected the new ceramic coating to combustion temperatures of 1,400 degrees C. (2,500 degrees F.) in a gas turbine engine. Previously, uncoated turbine blade metal temperatures were approximately 1,010 degrees C. (1,880 degrees F.). Now the metal temperature of a ceramic coated turbine blade in the same engine is 980 degrees C. (1,750 degrees F.). The drop of 130 degrees F. should increase the life of the turbine blade some 10 times that of existing uncoated blades.

The ceramic thermal barrier coating also permits an increase in operating temperatures of cooled energy-conversion machinery which results in efficiency improvement as well as smaller and more powerful gas turbine engines.

*Industrial Research* magazine each year presents its IR-100 Award to the 100 most significant new products developed during the year. Some 1,000 entries from industries throughout the country are received for consideration and judging by a panel of technical judges.

The three awards this year bring to 16 the number of awards won by the Lewis center since the center first entered the competion 11 years ago.

## Viking: The Mission Strategy

*Editor's Note: As the November issue of NASA Activities was being prepared, Viking scientists still were unprepared to announce the existence or nonexistence of a life form on Mars. Experiments have shown a certain amount of chemical action in Martian soil samples but whether it is attributable to biology or chemistry has not been determined. In this, the fifth installment of Dr. Carl Sagan's six-part article on the Viking mission, spacecraft operation is reviewed.*

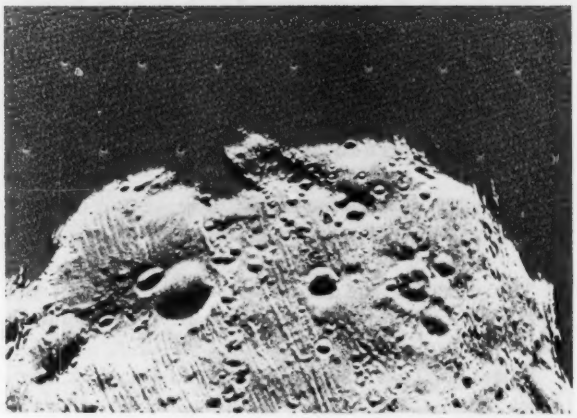
The Viking spacecraft's capabilities include orbital experiments for imaging, infrared thermal mapping, infrared water vapor detection, and radio science; atmospheric entry experiments for analysis of the neutral and ionized components of the Martian upper atmosphere; and lander experiments for imaging of the surface, atmosphere and other astronomical objects, for inorganic chemistry, meteorology, seismometry, magnetic properties of sand grains, organic chemistry of surface samples and analysis of the lower atmosphere, plus three compact biological experiments designed to search for any Martian microorganisms.

Viking is an expensive mission, costing almost a billion dollars; it has occupied hundreds of scientists and engineers for many years, some of us for more than a decade; and it holds the promise of revolutionizing the planetary sciences in general and the study of Mars in particular.

While the orbital television system obtains photographs of Mars with a resolution of two to three times better than the best images from Mariner 9, the prime function of the orbiter is lander support: to act as a radio link to Earth for the lander and to help certify preselected landing sites. The orbiters do not have, for example, the infrared and ultraviolet spectrometers that were so successful on Mariner 9. The primary objective of the Viking mission is to search for life on Mars, and this is not something easily performed remotely.

The key elements in both orbiter and lander are their onboard computers. The lander possesses—like a human being with his corpus callosum [band of fibers that unite the cerebral halves] cut—two identical brains. Each has an 18,000-word memory, with 24 bits per word, stored on two coupled magnetic wires. A memory of 18,000 words is quite large. Basic English, which is alleged to be serviceable in many layers of American society, consists of fewer than 1,000 words.

A scientific and engineering protocol is already in the Viking memory banks. Each lander's computers are checked by a data dump to see how well they remember and understand their program. In each case, the computer that has forgotten the least is put in charge. A third computer on Earth selects the winner. The loser is put to sleep, but waits in readiness; in case of an accident or senility in the winner, it may be called into action.



**Miniature Martian Moon**—This is the most detailed photo ever obtained of Mars' inner satellite, Phobos. The asteroid-sized moon was a photographed by Viking's TV camera from a distance of only 880 kilometers or 545 miles away; fine resolution picked up objects as small as 40 meters or 130 feet across. About half the moon can be seen, measuring about 18 km. (11 mi.) top to bottom and 9 km. (5.6 mi.) left to right. Phobos' north pole is near the upper left side. The moon is seen to be heavily cratered as was expected but, surprisingly, shows striations and chains of small craters. Similar chains of small craters on Earth's Moon, and on Mars and Mercury were formed by secondary cratering from a heavy impact. Answers to the Phobos puzzle may be provided by additional high-resolution photography by Viking cameras.

While it is certainly large, an 18,000-word vocabulary is inadequate for everything the Viking lander may be asked to do. (The sample arm motions alone require several hundred words.) Only 5,000 of its words are for functions to be performed exclusively after landing. The remainder are for executive matters, involving the structure of the entire computer program; checkout of engineering functions; and functions performed during descent to the Martian surface.

For this reason, the mission controllers have devised a "primary design," according to which, every six days a set of new commands, consisting of hundreds to thousands of words, is radioed uplink from Earth to Mars.

One clear lesson from past spacecraft is that enormous scientific payoffs follow from the ability to do new experiments on the basis of what we have just learned. Many of the most famous discoveries made by Mariner 9—the great volcanoes, the surfaces of Phobos and Deimos, variable features, great sand dune fields and details of the large sinuous channels—required the space probe's adaptive mode. An entirely preprogrammed Viking mission would be relatively feeble scientifically. It could not even select with the lander cameras the place where the sample arm is to dig. But a Viking

mission in which we can perform an experiment tomorrow on the basis of what we learned the day before yesterday—that is a scientific capability of stunning potentialities.

The Viking launches took place in August and September 1975 from Pad 41 at the Kennedy Space Center, Cape Canaveral, Fla. Any launch later than about Sept. 20 would have seriously degraded the mission, and might have required a 23-month "hold" until the next opportunity in 1977. NASA has a very good launch record, but there has never been as complex a scientific mission as Viking. The launch vehicle was the Titan 3E, a Titan booster with a Centaur second stage, a configuration that had been tried only twice before.

Lander 1 has a nominal working lifetime on Mars' surface of 58 days; Lander 2, 62 days (although the spacecraft are likely to work for a full year). The resources available to the Viking mission apparently will permit almost no simultaneous operation of major scientific experiments on the two landers.

This is a great pity, since synoptic observations are the key to a variety of fundamental problems. The difficulty is not spacecraft capability, but rather money to pay for ground personnel and mission control computers. Despite its billion-dollar price tag, Viking is severely hampered by lack of funds.

A review of the systems involved in the Viking maneuvers serves to illustrate the complexity of the mission. The descent maneuver begins when a mechanical spring separates the orbiter and the lander, giving a relative velocity of a meter (slightly more than a yard) or two per second. The two follow essentially the same orbit for two hours, during which the lander orients itself for entry and examines the thin upper atmosphere of the Red Planet. It radios its findings to the nearby orbiter, which relays them directly to Earth as well as recording them on tape recorders for future playback. The entire descent sequence is under control of the active lander computer; the ground "controllers" are able only to bite their fingernails.

After an initial rocket burn, the lander enters the denser atmosphere, ablation shield first. After this burns off, the parachute is deployed and then, under control of the accelerometers with backup timing devices, is jettisoned. Finally, the terminal-descent rockets burn, to be turned off only about three meters (10 feet) above the Martian surface.

The entire delicate landing maneuver is actively controlled by the lander, relying on its descent radar and other instruments and maintaining a careful attitude control. It is an intricate servomechanism, making decisions on the basis of its sensory information, as we do. The lander free-falls the final few feet to land safely on its three spring-loaded footpads on the Martian surface.

**Orbiter 1 Takes a Walk**—A photomosaic of Mars Nilosyrtis region was the result of a two-week "walk" by the Viking orbiter. Moving some 40 degrees of longitude each day, the orbiter examined new areas all the way around the Martian globe. This photo shows a transitional zone between an ancient cratered terrain to the south (bottom) and a sparsely cratered terrain to the north. Principal features in the low-lying areas are suggestive of flow, and are suggestive of the presence of ground ice in the near-surface material of Mars.

Immediately upon setting down, the spacecraft initiates a range of engineering and housekeeping functions. It asks itself if it is feeling well. The lander relays data to Earth via the orbiter (when that is above the lander's horizon) at 16,000 bits per second and at other times directly to Earth, but at the much slower rate of 500 bits per second. During the following three days, it principally takes seismometric and meteorological data, as well as closeup pictures of the Martian terrain.

The meteorology package, on a small boom, examines other atmospheric properties including wind velocity and direction. Evening weather reports on American television can include reports on meteorological conditions at the two locales on Mars.

We know that despite the thinness of the Martian atmosphere, winds are occasionally strong enough to raise enormous clouds of sand and dust. It is interesting to try to correlate wind speeds as measured by the meteorology experiments with the amount of atmospheric dust as measured from above by the orbiter, and from below by the two Viking television cameras. The cameras are able to see dust clouds in the vicinity of the spacecraft and at the horizon, and also can determine the mobility of samples of dust and sand dumped by the sample arm on a specially prepared grid on the horizontal surface of the spacecraft.

The lander cameras are able to see detail about as well as, in some respects better than, a human being standing on Mars. Cameras are able to image as far as 1.2 microns into the infrared and are thus able to perform much better stereo imaging than human eyes can because the two cameras are much farther apart than the characteristic few inches of our eyes. Color stereoscopic panoramic photographs of the two landing sites on Mars, horizon to horizon, can be made over a period of many months.

On the third day after landing, the first set of uplink commands arrives. By the sixth day, a decision will have been made on where to obtain the first soil sample with the sample arm. On the eighth day, after the onboard computer has demonstrated that it truly understands its newly arrived instructions on where to dig a hole, the sample arm gingerly extends itself towards the surface. It can reach a soil sample (or a more interesting object) as far away as three meters (10 feet). With a nervous jittery backhoe motion, it lifts its sample into the air and gradually retracts, telescoping itself until it is only a few inches from the lander's main body. Photographs are taken before, during and after the sampling operation. The arm then positions itself over one or more of the three entry bays. One is for the X-ray fluorescence experiment, to examine the inorganic chemistry of molecules with atoms heavier than about mass number 20; another is for the gas chromatograph-mass spectrometer (GCMS), to examine the organic chemistry of the samples; and the last is for the three different microbiology experiments.

The arm opens its little claw, shakes itself and deposits the sample into a funnel which is covered by a wire mesh screen. Experimenters back on Earth will have decided whether they want the same sample for each experiment.

The experiments then do their stuff, which may take some days. The biology experiments, for example, require an incubation period before the results can be radioed downlink to Earth. In all, three samples will be examined by each of the three biology experiments, four by the GCMS, and five by X-ray fluorescence, all during the nominal mission of each lander.

We can examine the properties of the Martian surface near the lander fairly thoroughly. The sample arm digs trenches and, using Viking's eye-hand combination, allows for simple experiments on surface properties. If we are very lucky we might get some information on the ages and mechanisms of the channel cutting process of ancient rivers. The deeper interior of the planet is investigated by an elegant seismometer that listens for marsquakes—if there are any. Since we know from our Mariner 9 experience that Mars recently has been tectonically active, we expect much higher levels of seismic activity than were detected by seismometers on the Moon.

An X-ray fluorescence spectrometer provides insights into the mineralogy and geochemistry of the Martian surface, and an indication of what sorts of geological processes have been operating—whether liquid water once flowed on Mars, for instance.

We look for characteristic chemical signatures in the GCMS experiment as evidence of possible life on Mars. Alternatively there may be organic compounds there from carbonaceous chondrites, organic-rich meteorites originating in the asteroid belt and falling now and then on Mars. Finally, there may be non-biological synthesis of organic matter by ultraviolet light in the present oxygen-poor Martian atmosphere. We hope that the GCMS experiment will be able to distinguish among these possibilities. It will also search for time variations in the chemistry of the Martian atmosphere. The microbiology experiments range from one which makes very specific assumptions about Martian microbial metabolism but which has very high sensitivity, to one which makes only very general assumptions but has a much lower detectivity.

The GCMS and biology experiments are by far the most expensive scientific instruments ever flown in the unmanned planetary program. But the questions being asked are very fundamental. We do not know beforehand the nature of Martian life, if any, and there has been no previous experience in designing,

testing and flying space vehicle experiments oriented towards organic chemistry and microbiology. We get what we pay for, by and large. With these instruments developed, the incremental cost of future investigations of the organic chemistry and biology on Mars will be much lower.

After the Viking 2 lands, high-data-rate transmission from the Viking 1 lander is turned off for the economy reasons mentioned above. Only low-data experiments on the direct link to Earth can be performed, chiefly seismometry, meteorology and single-line video scans. The Viking 1 orbiter, freed of its relay responsibility for its lander, now exuberantly explores Mars from orbit. Many questions posed by Mariner 9 may be answered at this stage.

This is also the first time in the mission when radio occultation experiments will be performed as the atmosphere and the planet intercept the transmission from orbiter to Earth. Eventually, the Orbiter 1 may be called back to service the Lander 2 (a function possible only if the longitudes of the nominal 1 and 2 landing sites are very nearly the same). If this occurs, the inclination of 2's orbital plane to the equatorial plane of Mars can be increased to 75 degrees, converting the Viking 2 orbiter into a Martian polar observatory. Many other comparably elegant combined mission strategies are possible.

Mars will be in solar conjunction on Nov. 25, 1976, when the Sun will be between the planet and the Earth. Communication with the Viking spacecraft will be interrupted from Nov. 8 until Christmas Day.

The generosity of nature is evident here: Viking scientists will finally be able to take time out from data gathering to ponder what the data mean. Many space missions never provide such an opportunity until they are over.

If all is still working well, the Viking Extended Mission may begin early in 1977. While the nominal lifetime of a Viking spacecraft is only about 90 days, Mariner 9, with a similar life expectancy, performed for a full year, failing only because it ran out of consumables. Viking lander's power source is independent of sunlight; it runs on the decay of radioactive plutonium. If it is as well engineered as Mariner 9 was, the really interesting part of the Viking mission may begin in January 1977. In any case, planetary astronomy will never be the same again.

If after a long series of post-Viking investigations of Mars we find no sign of life on the planet, we will then have discovered something of considerable importance about the unlikelihood of life originating and surviving on another planet not very dissimilar to our own, a finding which will underscore the preciousness and rarity of what has happened here on our small Earth. And if we are lucky enough to find life on Mars, that event will clearly open a new epoch in the history of biology, our view of ourselves and our place in the cosmos. ■ ■ ■ ■

**Schooling for a Space Pilot**—Astronaut Fred W. Haise, Jr. (in background), commander of the first Space Shuttle approach and landing tests scheduled to begin next year, seated at the controls of a Shuttle orbiter trainer at the Johnson center. A training officer is in foreground.

*Loftis*

*Funston*

**MSFC Women Earn Important Rating**—Two members of the MSFC-Redstone chapter of the National Secretaries Association (international) recently earned the coveted rating of Certified Professional Secretary (CPS).
The ratings of Glyndon K. Loftis and Catherine D. Funston were announced recently at the NSA's 31st Annual Convention and International Forum in Houston, Texas.
Loftis joined the Marshall center in 1965 and is secretary to the Director of Facilities office. Funston too has been employed at the center since 1965. She is secretary to the Chief of the Program Project division in the facilities office.

## New NASA Publications

**Fuel-Saving Aircraft,** a public affairs folder, describes in laymen's terms the aviation fuel-saving technologies being pursued by NASA. The illustrated black-and-white folder is available free at NASA public information and educational offices.

**NASA Educational Publications,** a 12-page brochure, describes and gives prices of NASA-produced educational, informational and popular scientific publications that may be purchased from the U.S. Government Printing Office. The brochure is available free at NASA public information and educational offices.

## Radio-Television

*(Released Nationally)*

TELEVISION: A 4½-minute and a 90-second film have been released in the *Aeronautics and Space Report* monthly series, entitled "Energy Satellite Research."

RADIO: Four weekly *Space Story* programs have been released—"Voice Actuated Wheel Chair;" "Remote Sensing;" "Starphac;" "The Space Telescope." One monthly NASA *Special Report* has been released—"The Space Telescope," featuring Dr. George Field, Smithsonian Astrophysical Observatory.

One set of ten 60-second NASA *Space Notes* announcements on a variety of subjects including Space Colonization, Tech House, Voice Actuated Wheel Chair, Hydrogen Fueled Vehicle, etc.

## Launches for 1976—Completed and Projected

| Name | Launch Date | Vehicle | Range | Mission Remarks |
|---|---|---|---|---|
| Helios-2 | Jan. 15 | Titan/Centaur | ETR | Scientific satellite to investigate the properties of interplanetary space close to the Sun. Cooperative with Germany. |
| CTS | Jan. 17 | Delta | ETR | Experimental high-powered communications satellite. Cooperative with Canada. |
| Intelsat IVA-F2 | Jan. 29 | Atlas/Centaur | ETR | Comsat communications satellite—reimbursable. |
| Marisat-1 | Feb. 19 | Delta | ETR | Comsat maritime communications satellite—reimbursable. |
| RCA-B | March 26 | Delta | ETR | Second RCA (Satcom) domestic communications satellite—reimbursable. |
| NATO-III A | April 22 | Delta | ETR | Communications satellite for the North Atlantic Treaty Organization—reimbursable. |
| Lageos-1 | May 4 | Delta | WTR | To demonstrate space techniques that will contribute to the development and validation of predictive models for earthquake hazard alleviation, ocean surface conditions and ocean circulation. |
| Comstar-1 | May 13 | Atlas/Centaur | ETR | Domestic communications satellite for Comsat—reimbursable. |
| Air Force Test | May 22 | Scout | WTR | USAF scientific payload—reimbursable. |
| Marisat-B | June 9 | Delta | ETR | Second Comsat satellite to provide maritime satellite communications service—reimbursable. |
| Relativity | June 18 | Scout | Wallops | Scientific probe to test the Einstein Theory. |
| Indonesia-A (Palapa) | July 8 | Delta | ETR | Indonesian communications satellite—reimbursable. |
| Comstar-2 | July 22 | Atlas/Centaur | ETR | Second domestic communications satellite for Comsat—reimbursable. |
| NOAA-5 | July 29 | Delta | WTR | Operational meteorological satellite of the National Weather Service to provide day and night cloud cover imagery—reimbursable. |
| Navy Transit | July 30 | Scout | WTR | Navy navigation satellite—reimbursable. |
| Marisat-C | Oct. 14 | Delta | ETR | Third Comsat satellite to provide maritime satellite communications service—reimbursable. |
| NATO III-B | Dec. 2 | Delta | ETR | Communications satellite for NATO—reimbursable. |

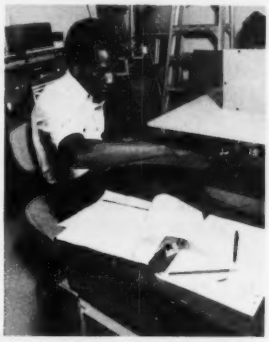
## Minority Students in Space Programs

The accompanying pictures show four of the eight students who recently completed a six-week work experience at the Goddard Space Flight Center. The eight youths were participants in Howard University's (at Washington, D.C.) Pre-freshman and Cooperative Education Program, called PREFACE. The objectives of the program are to increase the number of minority students enrolled in the university's engineering program, to ensure their academic and social preparedness for engineering study and to increase their probability of success.

The program will provide the Goddard center with a source for minority engineering co-op students.

At Howard, PREFACE utilizes available university resources such as the New Center for Academic Reinforcement, the University Counseling Service and the Summer School. Goddard supported the PREFACE program during the summer of 1976 by providing work experience for the eight students and tuition for their freshman year.

*Ona Kay Williams*



*Percy Owens*

*Paul D. Hill*

*Althea L. Ortique*

**Gubernatorial Dry Run**—Governor Cecil D. Andrus of Idaho gets the feel of NASA's Earth Resources Survey Aircraft (U-2) cockpit during a September meeting of the Pacific Northwest Commission at Ames Research Center. Bradford Johnson, NASA Headquarters Associate Administrator for Applications (left), Governor Robert W. Straub of Oregon, and Ames Director Hans Mark (wearing suit) participated in a review of a cooperative program between NASA and the states of Oregon, Washington and Idaho, which makes use of aerial surveys of U-2 aircraft and data from Earth Resources Technology satellites.

**President Ford Briefed**—NASA Administrator Dr. James C. Fletcher demonstrates how the Space Shuttle will work when placed in orbit in 1980. President Ford later announced that the Orbiter vehicle 101 would be named *Enterprise*, after the spacecraft used on the television series, Star Trek.

## Inventions and Contributions Board Monetary Awards

*The Inventions and Contributions Board, at its meetings of December 18, 1975, January 29, and February 19, 1976, recommended that monetary awards be granted to the NASA employees and NASA contractor employees identified below for scientific and technical contributions to space and aeronautical activities. The recommendations were approved by the Administrator and the awards have been made.*

| Innovator(s) | Title of Invention and Contribution |
|---|---|
| Vernon J. Rossow | Apparatus for Span Loading to Alleviate Wake-Vortex Hazard Behind Aircraft |
| **GODDARD SPACE FLIGHT CENTER** | |
| Philip A. Studer | Three Phase Full Wave DC Motor Decoder |
| Robert E. Hunter | Method and Apparatus for Neutralizing Potentials Induced on Spacecraft Surfaces |
| Philip A. Studer | Magnetic Bearing System |
| Gerard Ascher | High Temperature Solar Absorber |
| **JOHN F. KENNEDY SPACE CENTER** | |
| Walter E. Parsons | Percutaneous Connector Device |
| **LANGLEY RESEARCH CENTER** | |
| Robert S. Rogowski, Edmund J. Conway | Method for Detecting Pollutants |
| Shimer Z. Pinchney | An Improved Static Pressure Probe |
| Claude T. Haley | Clock Setter |
| Bernard Spencer, Jr., John W. Wilkey, Jr., Beverly Z. Henry | Variable Dihedral Shuttle Orbiter |
| Harry V. Fuller | Binocular Attachment |
| Walt C. Long | Rotating Joint Signal Coupler |
| **LEWIS RESEARCH CENTER** | |
| Russell A. Lindberg | Improved Bimetallic Junctions |
| Lawrence P. Ludwig | Fluid Seal for Rotating Shafts |
| Jacob D. Broder | Silicon Nitride Coated, Plastic Covered Solar Cell |
| Henry W. Brandhorst, Jr. | Solar Cell Assembly |
| A. G. Birchenough | Sustained Arc Ignition Systems |
| **LYNDON B. JOHNSON SPACE CENTER** | |
| John T. Howarth, Arthur A. Massuco, Kenneth R. Sidman, Suresh G. Sheth | Flame Retardant Elastometric Compositions |
| Joe L. Day | Method of Making a Perspiration Biopotential Electrode |
| James C. Stamps | Television Noise Reduction Device |
| **MARSHALL SPACE FLIGHT CENTER** | |
| Lott W. Brantley | Thermal Energy Storage System |
| Walter J. Polstorff | Simulator for Practicing the Mating of an Observer-Controlled Object With a Target |
| John L. Burch, Peter H. Broussard, Calvin O. Mueller | An Improved Load Handling Device |
| Ambrose W. Byrd | Power System With Heat Pipe Liquid Coolant Lines |
| Robert S. Snyder | Method of Crystallization |
| Hans F. Wenscher | A Process for Forming Crystalline Film |
| Robert R. Belew | Emergency Descent Device |
| **AUBURN UNIVERSITY** | |
| Martial A. Honnell | Frequency Modulated Oscillator |
| **INSTITUTE FOR RESEARCH INCORPORATED** | |
| Dr. Benjamin Mosier | Method of Making a Perspiration Biopotential Electrode |
| **JET PROPULSION LABORATORY** | |
| Robin A. Winkelstein | Controlled Oscillator System |
| Ernest Z. Micka | Cross Correlation Anomaly Detection Technique |
| Allan R. McDougal | Disconnect Unit |
| Charles G. Miller, James B. Stephens | Sampler of Gas Borne Particles |
| Taylor G. Wang, Melvin M. Saffren, Daniel D. Elleman | Heat Operated Cryogenic Electrical Generator |
| Tage O. Anderson | Asynchronous, Multiplexing, Single Line Transmission and Recovery |
| Jung P. Hong | Real-Time Analysis of Voiced Sounds |
| Charles Elachi | Diffused Waveguiding Capillary Tube with Distributed Feedback for a Gas Laser |
| Charles G. Miller, Ralph E. Barterra | An Indicator Providing Continuous Indication of the Presence of a Specific Pollutant in Air |
| Alain L. Fymat | High-Resolution Fourier Interferometer-Spectrophotopolarimeter |
| Allen G. Ford | Motion Restraining Device |
| Cyril Feldstein, Gilbert W. Lewis, Robert H. Silver, Virgil H. Culler | Catheter Tip Force Transducer for Cardiovascular Research |
| John Houseman | Improvement in Combustion Engine |
| Lars-Goran Rosengren | Method and Apparatus for Background Signal Reduction in Opto-Acoustic Absorption Measurement |
| Jack H. Rupe | System for Minimizing Internal Combustion Engine Pollution Emission |

| | |
|---|---|
| Joseph Maserjian | Method and Apparatus for Measurement of Trap Density and Energy Distribution in Dielectric Films |
| Dr. Lewis P. Leibowitz | Annular ARC Accelerator Shock Tube |
| John Houseman, Donald J. Cerini | Thermal Hydrogen-Rich Gas Generator Utilizing Liquid Hydrocarbons and Air |
| John Houseman, Jack H. Rupe, Raymond O. Kushida | Hydrogen Rich Gas Generator |
| John Houseman | Improved Hydrogen Rich Gas Generator |
| **MARTIN MARIETTA CORPORATION** | |
| Harv Linebarier | Varying Density Composite Structure |
| **MASSACHUSETTS INSTITUTE OF TECHNOLOGY** | |
| Leonard S. Wilk | Pseudo-Diamagnetic Suspension and Pseudo-Diadielectronic Suspension |
| **OLD DOMINION UNIVERSITY** | |
| Ralph R. Richards | Method for Detecting Pollutants |
| **ROCKWELL INTERNATIONAL CORPORATION** | |
| Cyrus C. Haynie, Samuel V. Messineo | Apparatus for Positioning Modular Components on a Vertical or Overhead Surface |
| James R. Fenwick, George H. Karigan | An Improved Accumulator |
| Thomas R. George, Jr. | A Device for Installing Rocket Engines |
| **SOUTHERN METHODIST UNIVERSITY** | |
| Ting L. Chu | Growth of Gallium Nitrite Crystals |
| **TAFT BROADCASTING COMPANY** | |
| Bernard L. Gordon | Television Noise Reduction Device |
| **UNIVERSITY OF ALABAMA** | |
| Hans U. Walter | Method of Crystallization |
| Hans U. Walter | A Method and Apparatus for Continuously Processing a Single Crystalline Ribbon |
| **WESTINGHOUSE CORPORATION** | |
| F. C. Arcella, G. G. Lessmann | Improved Bimetallic Junctions |

## Lunar Sample Exhibits

*The following is a schedule of lunar sample exhibits from October 15 to November 15, 1976:*

**California**—Bicentennial Science/Technology Exposition, Sacramento, Oct. 18-27.

**Georgia**—USA Kitty Hawk to Moon-Thronateeska Heritage Foundation, Albany, Oct. 31-Nov. 14.

**Oklahoma**—Tulsa Rock & Mineral Society, Tulsa, Oct. 23-24.

**South Carolina**—Thornwell Museum, Clinton, Oct. 18-29.

**Texas**—Houston Museum of Natural Science/History. End of Caroline at Hermann Park, Houston, Oct. 15-Nov. 15.

**American Freedom Train**—Virginia: Roanoke, Oct. 16-19, Danville, Oct. 20-21; North Carolina: Winston-Salem, Oct. 22-26, Fayetteville, Oct. 27-28, Raleigh, Oct. 29-Nov. 1, Charlotte, Nov. 2-4; South Carolina: Greenville, Nov. 5-7, Columbia, Nov. 8-11, Florence, Nov. 12-14, Charleston, Nov. 15-18.

**High Flight Bicentennial Mobile Space Museum**—Virginia: Hampton, Nov. 14-21.

**Tennessee Valley Association**—Bicentennial Caravan—Tennessee: Tiptonville, Oct. 16, Dyersburg, Oct. 17-19, Ripley, Oct. 20, Covington, Oct. 21, Millington, Oct. 22, Memphis, Oct. 23-28.

### Long Term Displays

**Alabama**—Alabama Space & Rocket Museum, Marshall Space Flight Center, Huntsville.

**Florida**—Visitor Information Center, Kennedy Space Center.

**Kansas**—Eisenhower Library, 200 SE 4th Street, Abilene.

**Mississippi**—The National Space Technology Laboratories, Bay St. Louis.

**New York**—United Nations Building, New York City.

**Ohio**—USAF Museum, Wright Patterson AFB; Visitor Information Center, Lewis Research Center.

**Texas**—Johnson Library, University of Texas, Austin; Visitor Information Center, Johnson Space Center, Houston.

**Virginia**—Visitor Information Center, Langley Research Center, Hampton.

**Washington, D.C.**—National Geographic Museum; Smithsonian Institution, National Air and Space Museum, 400 Independence Ave.; Washington National Cathedral.

**International Honors**—Christine Duncan, a Marshall Center information specialist, was selected for International Honorary Membership in the National Secretaries Association (International) at the 31st Annual Convention and International Forum held recently in Houston, Texas. She was nominated for the honor by the MSFC-Redstone Chapter of NASA. She received one of two honorary memberships bestowed this year by the NSA International Board of Directors. A former secretary, Duncan worked for a newspaper and publishing company for several years before joining the public affairs office at the MSFC in 1969.

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### Boston Firemen Get New Breathing System

The first production units of a new, lightweight firefighter's breathing system, based on technology developed for the U.S. space program, recently were delivered to the Boston Fire Department by the manufacturer, Scott Aviation Co. of Lancaster, N.Y. (NASA *Activities* "1¢ Worth" of July 1975, described the gear.)

The occasion was marked by a ceremony held in Boston's City Hall Plaza attended by Boston city officials, and representatives from Scott Aviation Co., the National Fire Prevention and Control Administration, the International Association of Fire Fighters, the National Fire Protection Association and NASA.

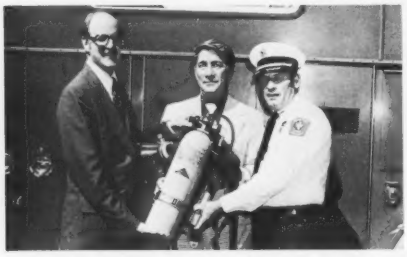
Boston is the first city in the U.S. to equip its firefighters with the new apparatus.

The new unit, called the Scott Air-Pak 4.5, is the first major improvement in compressed air breathing systems in more than 20 years. Although conventional units are considered acceptable, they are cumbersome to wear and tend to restrict a firefighter's mobility and vision. Among the new features of the improved system are: a 40 percent weight reduction, using a lightweight air bottle; an improved pack frame and harness that puts the weight of the unit on the hips instead of the shoulders; a redesigned face mask permitting better vision.

NASA involvement in development of the new system started almost seven years ago when the agency set up a user requirements committee consisting of fire officials, city managers and representatives of the National Bureau of Standards.

The NASA effort was carried out at the Johnson Space Center as an engineering applications project under the NASA Technology Utilization Program. Prototype units were successfully field-tested under firefighting conditions in several cities. Throughout the development and testing program for the NASA breathing system, information on all aspects of the effort was made available to the fire service community.

Scott Aviation Co., a division of A-T-O, Inc., was the first manufacturer to start production of an apparatus based on NASA's effort. NASA does not endorse commercial products developed as a result of its research, but it does encourage the widest possible use of its technology.



**Firefighting Gear Delivered**—Herbert J. Rowe, Associate Administrator for External Affairs (left), holds the first production unit of a new breathing system based on technology developed by NASA. With him are (center) Martin Pierce,, third district vice president of the International Association of Firefighters and Leo Stapleton, deputy chief of the Boston fire department. Stapleton was instrumental in getting NASA to apply its expertise to the development of the firefighter's breathing system, which represents the first major improvement in compressed-air breathing systems in more than two decades.

**Fireman Demonstrates New Equipment**—A Boston man wears a new firefighting breathing system that stems from space-related technology. The gear was developed by engineers at the Johnson Space Center.

NASA

National Aeronautics and Space Administration

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AMERICAN REVOLUTION BICENTENNIAL 1776-1976